SAFETY DEVICE FOR SNOWBOARDS

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates generally to sports equipment. The present invention relates more particularly to equipment for the sport of snowboarding, and to safety devices used to prevent injury while snowboarding.

2. Background

Snowboarding is a winter sport that has gained in global popularity and is now commonly practiced at most ski resorts in the United States. Many Americans have already purchased equipment for snowboarding. This equipment usually includes a snowboard, snowboarding boots, and bindings to attach the snowboarding boots to the snowboard.

Two general types of snowboard bindings are owned by Americans today: "strap-in" snowboard bindings and "click-in" snowboard bindings. Both types of bindings are attached to the snowboard by threaded fasteners and are not removed from the snowboard during use. Neither type of binding is designed to separate from the snowboard under the force of a crash.

With strap-in bindings, the snowboarding boot is attached to the bindings by straps that must be connected and tightened. The straps must be loosened and/or disconnected to detach the snowboarding boots from the bindings. Strap-in bindings also serve to structurally reinforce the snowboarder's ankles while snowboarding (i.e. when the straps are tightened). Because the strap-in bindings provide the necessary rigidity around the snowboarder's ankles, the snowboarding boots need not be designed to be rigid or stiff. Therefore, the snowboarding boots that are designed to be compatible with strap-in bindings can be designed to be comfortable for normal walking. However, the feature facilitating comfortable boot design does not significantly enhance safety while snowboarding nor significantly reduce the chance of injury while snowboarding. Contemporary strap-in bindings are not designed to allow the separation of the boots from the snowboard under the force of a crash.

Click-in bindings better facilitate the intentional attachment and detachment of the snowboarding boots to and from the bindings. With click-in bindings, the snowboarding boots are specially designed or adapted to attach to the bindings, and detach from the bindings, upon a specific intentional action accomplished by the snowboarder. A snowboarder typically needs to detach one foot from the snowboard at the bottom of the ski slope to enable the snowboarder to push that foot against the snow for self-propulsion to the ski lift. The snowboarder must then reattach the disconnected foot to the snowboard after arriving at the top of the ski slope. Therefore, the ease of intentional detachment and reattachment can be an important performance characteristic of snowboard bindings. However, snowboarding boots that are specially designed to function with click-in bindings are typically very stiff because the boot must provide the ankle reinforcement necessary for snowboarding, without the additional structural support provided by strap-in bindings.

Consequently such boots are less comfortable for walking than boots designed for use with strap-in bindings. Moreover, the feature facilitating intentional disconnection of the boots from the bindings does not significantly enhance safety nor significantly reduce the chance of injury. Contemporary click-in bindings are not designed to allow the separation of the boots from the snowboard under the force of a crash.

In contrast with snowboarding equipment, skiing equipment has evolved to include sophisticated safety release mechanisms in the bindings that attach ski boots to skis. These safety release mechanisms have prevented many ski-related injuries. However, such safety release mechanisms are absent in commercially available snowboarding equipment.

One reason why commercially available snowboard bindings have not yet evolved to include safety release mechanisms is the presence of at least one additional important design requirement: the need for simultaneous release of both bindings (one for each of the snowboarder's two feet) under the force of a crash. The release mechanisms that are typical of contemporary ski equipment do not satisfy that important design requirement. Therefore, there is a need for a practical safety release mechanism for snowboard bindings that can ensure simultaneous release of the bindings for both feet under the force of a crash. Furthermore, because of widespread fear among the purchasers of snowboarding equipment of the risk of injury associated with the release of only one snowboard binding and not the other, there is a commercial need for the safety release mechanism to provide clearly apparent and visually verifiable certainty in the simultaneity of the release.

Attempts have been made in the prior art to design a practical safety release mechanism for snowboard bindings. These designs seem to have been inspired by the safety release mechanisms developed for ski bindings, since their focus remains on the separation of each individual boot from all or part of its binding. The attempts have not contemplated a safety release that could separate standard snowboard bindings, including contemporary strap-in bindings, from the snowboard in response to the forces of a crash. Furthermore, prior art bindings for individual boots that release when that boot is twisted or lifted may not release when the snowboarder's entire trunk is twisted by the snowboard. When the torque applied by the snowboard to the snowboarder is about an axis normal to the snowboard, but is a torque about the longitudinal axis of the snowboarder's entire body rather than the twisting of an individual foot, prior art bindings for individual boots may perceive this torque as a lateral shear force in the plane of the snowboard and consequently may not release. Many snowboarders suffer injuries to their lower spine as a result of such torques. Thus, there is a need for a safety release mechanism that will release when a torque about an axis normal to the snowboard, but about the snowboarder's entire trunk rather than the twisting of an individual foot, exceeds a given threshold. Many prior art designs have been variants of click-in bindings that usually require the snowboarder to wear a specially designed or adapted boot. Many Americans have already purchased snowboard boots that they chose because of comfort, warmth, or style. Accordingly there is a need for a new safety release mechanism that will reduce the forces and torques applied to the snowboarder's legs and trunk during a crash, but will not render already-purchased snowboarding boots and bindings obsolete.

ADVANTAGES OF THE INVENTION

The disclosed invention provides a novel and effective safety device for snowboards. A preferred embodiment of the disclosed invention provides a safety release mechanism that has the advantage of being able to function with standard, already-purchased, contemporary snowboarding boots and bindings. Another advantage of the disclosed invention is that it provides a safety release mechanism that is responsive to crash forces and torques occurring in directions that are most likely to result in injury while snowboarding. For example, the disclosed invention has the advantage that it will release when a crash torque about an axis normal to the snowboard exceeds a given threshold, even where that torque is about trunk of the snowboarder's entire body rather than the twisting of an individual foot. A further advantage of the disclosed invention is that it provides a safety release mechanism having a force threshold for release that can be adjusted according to the magnitude of crash forces and torques that are expected for a particular snowboarder. For example, the force threshold for release can be adjusted according to the weight and ability level of the snowboarder. A further advantage of the disclosed invention is that it provides clearly apparent and visually verifiable certainty to a potential purchaser that, in the event of a crash, both bindings must always either release simultaneously or else not release at all. A further advantage of the present invention is that it provides a safety release mechanism that reduces the leverage that external objects can apply to the snowboarder's legs and trunk during and after a crash. A preferred embodiment of the present invention has the added advantage of continuing to prevent excessive spreading or crossing of the snowboarder's legs even after a safety release has occurred. Additional advantages and features of the invention will become apparent from the description that follows, and may be realized by means of the instrumentalities and combinations particularly pointed out in the appended claims.

SUMMARY OF THE INVENTION

According to one aspect of the invention, bindings that would normally be fastened to the snowboard are instead both fastened to a binding support platform. A platform retention assembly is fastened to the snowboard. The platform retention assembly includes preloaded compliant members that form interfaces with contours on the binding support platform. The interfaces prevent the binding support platform from separating from the platform retention assembly except when a force or torque applied to the snowboard exceeds a set threshold (i.e. except under crash conditions). The platform retention assembly includes firm members, surfaces, or edges that contact firm mating members, surfaces, or edges on the binding support platform to prevent pure translation of the binding support platform relative to the platform retention assembly in the plane of the snowboard. The firm members, surfaces, or edges, and the firm mating members, surfaces, or edges are arranged such that the locations of contact between them, when projected onto the plane of the snowboard, lie on a single circle.

According to another aspect of the invention, a platform retention plate is fastened to the snowboard. The binding support platform is part of a binding support platform assembly that includes preloaded compliant members that form interfaces with contours on the

platform retention plate. The interfaces prevent the binding support platform assembly from separating from the platform retention plate except when a force or torque applied to the snowboard exceeds a set threshold (i.e. except under crash conditions). The platform retention plate includes firm members, surfaces, or edges that contact firm mating members, surfaces, or edges on the binding support platform assembly to prevent pure translation of the binding support platform assembly relative to the platform retention plate in the plane of the snowboard. The firm members, surfaces, or edges, and the firm mating members, surfaces, or edges are arranged such that the locations of contact between them, when projected onto the plane of the snowboard, lie on a single circle.

Different practical applications of the invention can enhance various metrics of performance. For example, according to one practical application of the invention, the preload force of three or more of the preloaded compliant members that facilitate retention of the binding support platform can be adjusted simultaneously by setting the position of a single centralized component. According to another practical application of the invention, snow and debris are excluded from the retention mechanism and interfaces by a cover. Yet, according to another practical application of the invention, longitudinal flexibility is enhanced by leaving the retention mechanism uncovered and thereby arriving at a lower profile design. According to another practical application of the invention, longitudinal flexibility is enhanced by separating the platform retention plate into two plates, or separating the plate underlying the platform retention assembly into two pieces (each fastened to the snowboard). According to another practical application of the invention, cost is reduced by limiting the number of preloaded compliant members to three. Yet, according to another practical application of the invention, four interfaces are located near the corners of the binding support platform to enhance the transfer of controlling torques from the snowboarder to the snowboard.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a top view of a typical snowboard of the prior art.

FIG. 2 is a side view of a typical snowboard of the prior art.

FIG. 3 is a top view of a preferred embodiment of the disclosed invention when mounted on a snowboard.

FIG. 4 is a side view of a preferred embodiment of the disclosed invention when mounted on a snowboard.

FIG. 5 is an underside view of the binding support platform in a preferred embodiment of the disclosed invention.

FIG. 6 is a top view of the platform retention assembly in a preferred embodiment of the disclosed invention.

FIG. 7 is a cross-sectional illustration of the adjustable and releasable connection between the platform retention assembly and one interior corner of the binding support platform in a preferred embodiment of the disclosed invention, as viewed from above.

FIG. 8 is a cross-sectional illustration of the connection between the platform retention assembly and one interior corner of the binding support platform in a preferred embodiment of the disclosed invention, as viewed from below.

FIG. 9 is a simplified cross-sectional illustration of the interface between the platform retention assembly and a contour of one interior corner of the binding support platform in a preferred embodiment of the disclosed invention, as viewed from the side.

FIG. 10 is a top view of a platform retention assembly in a preferred embodiment of the disclosed invention that better accommodates longitudinal bending while reducing torque backlash.

FIG. 11 is a top view of another preferred embodiment of the disclosed invention that better accommodates longitudinal bending, viewed mounted on a snowboard.

FIG. 12 is a side view of a preferred embodiment of the disclosed invention that better accommodates longitudinal bending, viewed mounted on a snowboard.

FIG. 13 is a top view of a platform retention assembly in a preferred embodiment of the disclosed invention that better accommodates longitudinal bending.

FIG. 14 is an underside view of the binding support platform in a preferred embodiment of the disclosed invention that better accommodates longitudinal bending.

FIG. 15 is a top view of the platform retention assembly of a lower cost alternative embodiment of the disclosed invention.

FIG. 16 is an underside view of the binding support platform of a lower cost alternative embodiment of the disclosed invention.

FIG. 17 is an underside view of the binding support platform of a preferred embodiment of the disclosed invention in which the binding support platform and most of the retention mechanism form a single assembly.

FIG. 18 is a top view of the platform retention plate of a preferred embodiment of the disclosed invention in which the binding support platform and most of the retention mechanism form a single assembly.

FIG. 19 is a simplified side-view cross-sectional illustration of the interface between the binding support platform assembly and one retention contour on the platform retention plate, in a preferred embodiment of the disclosed invention in which the binding support platform and most of the retention mechanism form a single assembly.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS OF THE INVENTION

Referring now to **FIG. 1**, a top view of a typical snowboard **1** of the prior art is shown. The snowboard **1** has a leading edge **2**, a trailing edge **3**, a left edge **4**, and a right edge **5**. Direction axis **X** and direction axis **Y** are indicated in **FIG. 1**, and will be used consistently when describing directions anywhere in this specification. Direction **X** always points longitudinally with respect to the snowboard, whereas direction axis **Y** always points laterally with respect to the snowboard. Both direction axis **X** and direction axis **Y** are parallel with, but not necessarily co-planar with, the top surface of snowboard **1**. A leading group of shallow threaded holes **6** is provided to facilitate fastening of one binding to the snowboard,

and a trailing group of shallow threaded holes **7** is provided to facilitate fastening of the other binding to the snowboard.

FIG. 2 shows a side view of a typical snowboard **1** of the prior art. Direction axis **Z** and direction axis **X** are indicated in **FIG. 2**, and will be used consistently when describing directions anywhere in this specification. Direction **Z** always points vertically upwards with respect to the snowboard, and is normal to the top surface of snowboard **1**.

Contemporary snowboards are designed to predominately facilitate sliding in the **X** and **-X** directions, but also to allow sliding in other directions. One way that sliding in the **X** and **-X** directions is preferentially facilitated by contemporary snowboard design is through choice of aspect ratio that is, the snowboard is longer along the **X** axis than it is wide along the **Y** axis. Typical snowboard aspect ratios serve to enhance the interaction of edges **4** and **5** with the underlying snow or ice. A second way that sliding in the **X** and **-X** directions is preferentially facilitated by the snowboard design is by the existence of rocker curves **8** and **9**. Rocker curves **8** and **9** prevent leading edge **2** and trailing edge **3** from interacting with the underlying snow or ice, and allow the snowboard to more easily travel over surface discontinuities when traveling in the **X** or **-X** direction.

FIG. 3 shows a top view of a preferred embodiment of the disclosed invention when mounted on a snowboard. **FIG. 4** shows a side view of the same preferred embodiment. The preferred embodiment includes a binding support platform **10** having regions **11**, **12**, and **13.** The top surface of region **13** of the binding support platform is raised in the view of **FIG. 3**, relative to the top surface of regions **11** and **12**. This relationship is apparent in **FIG. 4**. Region **11** of binding support platform **10** includes a group of shallow threaded holes **15** that are functionally similar to group **7** in the prior art. Region **12** of binding support platform **10** includes a group of shallow threaded holes **14** that are functionally similar to group **6** in the prior art. The shallow threaded holes of groups **14** and **15** facilitate the fastening of conventional bindings to binding support platform **10**. The conventional bindings are then used to attach the snowboarder's boots to binding support platform **10** in the same way that conventional bindings are used to attach the snowboarder's boots to the snowboard in the prior art. The shape of regions **11** and **12** optionally can be changed from that shown, so long as an adequate structural medium is maintained in which to locate and support a fastening means for the bindings (e.g. a fastening means such as the threaded hole groups **14** and **15**).

In a preferred embodiment, binding support platform **10** includes internal contours or facets in region **13** that interface with preloaded compliant members of an underlying platform retention mechanism. These interfaces serves to retain the binding support platform on the snowboard during normal use (i.e. except when crash forces exceed a certain threshold). In that preferred embodiment, the platform retention mechanism underlying region **13** is a separate assembly that includes plate **21** and remains fastened to the snowboard even if binding support platform **10** separates from the retention mechanism under crash conditions.

In the embodiment of **FIG. 3**, region **13** of the binding support platform is optionally designed to also serve as a cover to exclude snow and debris from the region of the retention mechanism. The cover need not be square in shape; its shape could be rounded or otherwise externally styled around or above the retention mechanism. An access hole that facilitates adjustment and setting of release force threshold is optionally covered by cap **16** to exclude

snow and other debris. Binding support platform **10** optionally includes a separate window **20** through which to view threshold release force adjustment and setting.

Region **13** of the binding support platform need not serve any dual purpose as a cover; rather, region **13** optionally can be made lighter and more flexible by intentionally including holes and other regions of reduced coverage. There is also considerable design freedom in choosing the thickness and material for the binding support platform. Suitable materials include composite materials such as fiberglass, carbon fiber reinforced epoxy, and other fiber reinforced composites, high strength plastics, and metals. Furthermore, the designer has the freedom to use changes in geometry, such as localized changes in thickness, holes, slots, and ribs, in order to reach an engineering compromise between the need for high lateral and torsional stiffness in certain areas of the binding support platform, versus the desired characteristic of longitudinal flexibility over its total length.

The aforementioned engineering compromise can be more specifically described by reference to **FIG. 3**. In the preferred embodiment shown, there is a need for high lateral and torsional stiffness in the area between the group of shallow holes **14** and the two leading interior corners of region **13** of binding support platform **10**. There is also a need for high lateral and torsional stiffness in the area between the group of shallow holes **15** and the two trailing interior corners of region **13** of binding support platform **10**. However, longitudinal compliance to flexing of the underlying snowboard is desired over the length of the binding support platform. The preferred embodiment shown in **FIG. 3** and **FIG. 4** shows an example of changes in geometry that can be made to enhance the outcome of the aforementioned engineering compromise. The preferred embodiment shown in **FIG. 3** and **FIG. 4** optionally includes vertical stiffening ribs **17** and **18,** and vertical slots **22 - 25** on the sides of the binding support platform **10** in region **13**. Optional vertical slots **22 - 25** are included to enhance the overall longitudinal flexibility of this preferred embodiment without sacrificing lateral or torsional stiffness in the aforementioned regions where such stiffness is desired. Optional stiffening ribs **17** and **18** increase the lateral stiffness of the bottom edge of the binding support platform **10** in region **13**, to compensate for an undesired increase in lateral flexibility of the bottom edge that would otherwise result from the inclusion of vertical slots **22 - 25**.

The top surface of region **13** can optionally include traction-enhancing texturing or holes, slip resistant pads or matting, and/or adhesive. Such traction enhancing surfaces may be used to reduce slippage when surface **13** is incidentally or intentionally stepped on for balance (or rest) while the snowboarder uses one detached foot for self-propulsion. Region **13** of binding support platform **10** is shown with a traction enhancing texture in the embodiment of **FIG. 3** and **FIG. 4**.

A preferred embodiment of the disclosed invention includes an optional leash **19** that is shown in **FIG. 3** and **FIG. 4** having one end attached to the snowboard and the other end attached to the binding support platform. Leash **19** is intended to prevent runaway of the snowboard too far from the snowboarder if the binding support platform (to which the snowboarder is attached) separates from the snowboard during a crash. It is possible to attach one end of optional leash **19** to plate **21** of the platform retention assembly rather than to the snowboard. It is also possible to attach the other end of optional leash **19** to a binding or to the snowboarder rather than to binding support platform **10**.

FIG. 5 shows the underside of the binding support platform of the same preferred embodiment that is shown in **FIG. 3** and **FIG. 4**. Surface **32** is the underside of region **11**. Surface **33** is the underside of region **12**. Surface **31** covers the underside of region **13**, and is recessed in this view. Cover surface **31** is included optionally to exclude snow and other debris, however it is also an important structural member in this particular embodiment because of the presence of optional vertical slots **22-25**. In this preferred embodiment, interior corners **26 - 29** of the binding support platform include three dimensional contours or facets for interfacing with a retention mechanism that will be described below. In this preferred embodiment, binding support platform **10** is a single piece frame with no moving parts. Access hole **30** through optional cover surface **31** can be seen in **FIG. 5** although it was covered by optional cap **16** in **FIG. 3**.

FIG. 6 shows a top view of the platform retention assembly in a preferred embodiment of the disclosed invention. Underlying plate **21** holds together platform retention assembly **45** in this embodiment. There is considerable design freedom in choosing the thickness and material for underlying plate **21**, so as to arrive at an engineering compromise between the need for adequate stiffness and the desired characteristic of overall longitudinal flexibility, subject to cost constraints imposed by the market for the product. A practical choice having low cost is to select a thin sheet of spring steel. Groups **34** and **35** of through-holes and slots are positioned and dimensioned to facilitate fastening of plate **21** to groups **6** and **7** of shallow threaded holes on the top surface of snowboard **1**. If special fasteners, that allow sliding in the **X** direction but do not allow separation in the **Z** direction, are used in the slots of group **35** while standard fasteners are used in group **34**, then the overall longitudinal flexibility of the preferred embodiment can be practically enhanced. Examples of standard fasteners include standard bolts and machine screws. An example of a special fastener is a modified machine screw having a lower threaded portion and an upper unthreaded portion. The lower threaded portion has a smaller diameter than the upper unthreaded portion. The boundary between the lower threaded portion and the upper unthreaded portion serves as an insertion stop or limiter that limits insertion of the machine screw as it is tightened. The upper unthreaded portion is capped by a driving head that protrudes radially sufficiently to prevent **Z** motion of plate **21**, and the unthreaded portion itself is dimensioned to allow **X** direction sliding motion of slots in group **35** but to prevent **Y** direction sliding. Such dimensioning is obtained if the upper unthreaded portion of the special fastener has a diameter nearly equal to the width of one individual slot in group **35** a dimensioning well known in the art as a "slip fit."

In the preferred embodiment of **FIG. 6**, raised ribs **36 - 39** rise in the **Z** direction from the surface of plate **21**. Ribs **36 - 39** can be separate parts attached to plate **21** by standard fasteners such as machine screws inserted from the back of plate **21**, by welding, or by a strong adhesive in the case where ribs **36 - 39** are fitted into recessed groves in plate **21** to increase the shear strength of the bond. Alternatively, plate **21** can be molded or formed to include ribs **36 - 39** as a single part. Since ribs **36 - 39** of the preferred embodiment of **FIG. 6** are curved, if the ribs are to be manufactured by press forming then holes may be required in plate **21** to prevent warping and other distortion of the plate. The outside edges of ribs **36 - 39** contact the inside edges of region **13** of binding support platform **10**, preventing "pure" lateral and longitudinal motion of binding support platform **10** in the **X - Y** plane relative to plate **21**. What is meant by "pure" lateral and longitudinal motion of binding support

platform **10** in the **X - Y** plane, is lateral or longitudinal motion relative to plate **21** occurring without separation of binding support platform **10** away from plate **21** in the **Z** direction. The ribs **36 - 39** do not, by themselves, prevent motion of binding support platform **10** relative to plate **21** in the **Z** direction. In the preferred embodiment shown in **FIG. 6**, ribs **36 -39** are curved and arranged in a single circle in the **X - Y** plane so that they do not, by themselves, prevent rotation of binding support platform **10** relative to plate **21** about the **Z** axis. The ribs **36 - 39** are also given some vertical curvature in the outer surface of their cross-sectional aspect so that they do not, by themselves, prevent rotation of binding support platform **10** relative to plate **21** about the **X** axis or **Y** axis (as would occur if binding support platform **10** separated from plate **21** as a result of a torque about the **X** axis or **Y** axis). In another preferred embodiment, ribs **36 - 39** are replaced by discrete pegs rising from the surface of plate **21** and having outside edges that are arranged in a single circle in the **X - Y** plane.

In the preferred embodiment of **FIG. 6**, adjustable preloaded plunger assemblies **40 - 43** are part of platform retention assembly **45** and are fastened to plate **21**. In this embodiment, the preload forces of all plunger assemblies are simultaneously adjusted by the rotation and locking of a single adjustment cam **44**. However, in another embodiment the preload force of each plunger assembly is individually adjusted, for example, by turning and locking a threaded adjustment plunger. In the embodiment of **FIG. 6** and **FIG. 7**, the locked position of adjustment cam **44** corresponds to the setting of release force threshold, with such setting observable on scale **54** which is comprised of marks on the surface of plate **21**.

FIG. 7 is a cross-sectional illustration of the adjustable and releasable connection between platform retention assembly **45** and one interior corner of binding support platform **10** in a preferred embodiment of the disclosed invention, as viewed from above. The hatched area is a cross section (in an **X - Y** plane) of inner corner **29** of the binding support platform, as viewed from above. We see in this view that each preloaded plunger assembly in the preferred embodiment of **FIG. 7** includes a housing **59**, a spring **48**, a sliding adjustment plunger **47**, and a sliding retention plunger **46**. In this embodiment, the adjustment cam **44** is designed to be rotated using a forked tool having two or three prongs that mate with opposing radial slots such as slot **49** in cam **44**. Adjustment cam **44** is locked into place by the action of a locking mechanism such as bolt **50** and lock washer **51**.

In the preferred embodiment of **FIG. 7**, preloaded spring **48** presses the retention plunger **46** against tilted facets **52** and **53**. Tilted facets **52** and **53** form part of a three dimensional contour adjacent to inner corner **29** of binding support platform **10**. In the embodiment of **FIG. 7**, facets **52** and **53** are seen to form a 90° interior angle with respect to each other in the **X - Y** plane. However, facets **52** and **53** could be oriented to have any interior angle with respect to each other in the **X - Y** plane less than 180° but large enough to accept plunger **46**. Larger angles in the **X - Y** plane enable release of binding support platform **10** at lower torques about the **Z** axis, whereas smaller angles raise the release threshold for torques about the **Z** axis.

In the preferred embodiment of **FIG. 7**, facets **52** and **53** are also tilted with respect to the **Z** axis so that retention plunger **46** will impart a retention force to binding support platform **10** that can resist limited separation forces in the **Z** direction and therefore also resist limited separation torques about the **X** axis and **Y** axis. If facets **52** and **53** were not tilted with respect to the **Z** axis, but were instead made parallel to the **Z** axis, then the only retention force available to resist vertical separation forces and torques would be the force of friction at

the interface between the facets and retention plunger **46**. However, when facets **52** and **53** are oriented in the design to form an angle relative to the **Z** axis, that angle grossly affects the vertical force or torque that is required to overcome the force imparted by retention plunger **46**. The specifics of this effect will be described in greater detail below, with reference to **FIG. 9**.

Based on the foregoing description, it should now be apparent to a skilled artisan that selection of the angular orientation of facets **52** and **53** gives the designer the freedom to predetermine a ratio of release thresholds for out-of-plane torque versus in-plane torque, within a wide range. The absolute release threshold for both can then be easily adjusted by the user by adjustment of cam **44** (within a range set by the designer through selection of the stiffness and length of spring **48** and the stroke of adjustment cam **44**).

FIG. 8 is a cross-sectional illustration of the connection between platform retention assembly **45** and interior corner **29** of binding support platform **10**, as viewed from below in a preferred embodiment. Structural supports **55** and **56** for a preloaded plunger assembly are seen in cross-section in **FIG. 8**, as viewed cut away in an **X - Y** plane from plate **21**. Facets **57** and **58** of interior corner **29** of binding support platform **10** are visible in **FIG. 8**, because facets **57** and **58** are visible from below in this embodiment. It should be clearly understood that facets **57** and **58** are not the same as facets **52** and **53**. Facets **52** and **53** are not visible from below; rather facets **52** and **53** would be visible from above in the preferred embodiment if not obscured by the top surface of region **13** of binding support platform **10**. Unlike facets **52** and **53**, facets **57** and **58** do not affect the threshold release forces and torques in this preferred embodiment. Rather, facets **57** and **58** serve only to enable forcible reattachment of binding support platform **10** onto platform retention assembly **45** (for example, after a release), without requiring the user to first loosen cam **44**. To accomplish such forcible reattachment, the user first positions binding support platform **10** over platform retention assembly **45** such that facets **57** and **58** of each interior corner rest on the tips of the plurality of retention plungers **46**, and then the user presses down on binding support platform **10** (usually by standing or jumping on it) so that it is forced in the **-Z** direction. After forcible reattachment, the plurality of retention plungers **46** are no longer in contact with facets **57** and **58** of each interior corner of the binding support platform; rather, the retention plungers are again spring loaded against facets **52** and **53** of each interior corner. The specifics of this change will be described in greater detail below, with reference to **FIG. 9**.

FIG. 9 is a simplified cross-sectional illustration of the interface between platform retention assembly **45** and a single facet **52** of a contour in one interior corner of binding support platform **10**, as viewed from the side. **FIG. 9** is described as "simplified" for four reasons. First, interior corner **29** of binding support platform **10** is viewed in cross-section but the retention plunger **46** is not. The cross section is taken in an **X - Z** plane near the point where retention plunger **46** touches facet **52**. Second, retention plunger **46** appears in **FIG. 9** as it would appear if it contacted facet **52** at a point on the plunger's vertical longitudinal bisecting plane. However, according to the aforedescribed preferred embodiment, retention plunger **46** contacts facet **52** at a point on a non-vertical longitudinal bisecting plane of the plunger. Third, the plunger assembly in **FIG. 9** is shown in a pure side view, as if the plunger assembly housing **59** were oriented parallel to the **X** axis. Actually, the plunger assembly may be at a significant angle with respect to the **X** axis in a preferred embodiment,

so as to appear shorter in **FIG. 9** if the figure were not simplified. For example, in the preferred embodiment shown in **FIG. 6** and **FIG. 8**, the plunger assemblies **40 - 43** are oriented at 45° angles with respect to the **X** axis. Fourthly, all lines representing adjacent facets **53** and **58** have been eliminated to present an uncluttered and simple illustration of the interface of plunger **46** with a single facet. **FIG. 9** shows (in simplified view) how, in a preferred embodiment, the interface between retention plunger **46** and facet **52** helps to retain one interior corner of binding support platform **10** against the action of a limited separating torque or force in the **Z** direction. However, the simplifications made to **FIG. 9** prevent it from showing how the interfaces between retention plunger **46** and facets **52** and **53** serve to resist limited torques about the **Z** axis. That aspect of the aforedescribed preferred embodiment was more clearly described earlier with reference to **FIG. 7**.

Referring now to **FIG. 9**, it can be seen that facet **52** of a preferred embodiment is tilted with respect to the vertical (**Z**) axis. If facet **52** were not tilted with respect to the **Z** axis, but were instead made vertical (parallel to the **Z** axis), then the only retention force produced by the interface (of retention plunger **46** and facet **52**) to resist vertical separation forces and torques would be the force of friction. However, when facet **52** is oriented in the design to form an angle relative to the **Z** axis, that angle grossly affects the vertical force or torque that is required to overcome the force imparted by retention plunger **46**. Specifically, if the angle of facet **52** is tilted in the design to appear steeper as viewed in **FIG. 9**, then the retention threshold for vertical separation forces and torques will be reduced. Conversely, if the angle of facet **52** is tilted in the design to appear less steep as viewed in **FIG. 9**, then the retention threshold for vertical separation forces and torques will be increased.

FIG. 9 also more clearly shows how a single facet **57** can contribute to the previously described attribute of this preferred embodiment that binding support platform **10** is capable of forcible reattachment to platform retention assembly **45**. To accomplish forcible reattachment, the user first places binding support platform **10** on platform retention assembly **45** such that facet **57** is resting on top of retention plunger **46**. Next, the user presses down on binding support platform **10** so that retention plunger **46** is momentarily forced to the left (as viewed in **FIG. 9**), and then, as the retention plunger again moves to the right, the point of contact between retention plunger **46** and binding support platform **10** moves from facet **57** to facet **52**. If the designer chooses a material for fabricating binding support platform 10 that has insufficient stiffness or toughness to prevent unacceptable wear or distortion at the locations where contact is made with retention plungers **46** (for example, wear occurring after several forcible reattachments), then the facets or three dimensional contours can be made of, covered by, plated with, or coated with a different material having better wear characteristics.

FIG. 10 description shows a platform retention assembly **70** of an alternative embodiment of the disclosed invention that has increased longitudinal flexibility. Platform retention assembly **70** includes a two-piece underlying plate having plate pieces **60** and **61** connected by sliding joints **66** and **67**. The cross-sectional profile of sliding joints **66** and **67** is fashioned to include a mating groove or step that allows sliding in the **X** direction but prevents relative motion in the **Z** direction and **Y** direction between plate pieces **60** and **61**. Alternatively, plate piece **61** could be fashioned to include local overhanging top plates or protrusions in the regions of the sliding joints, to overlap plate piece **60** and prevent it from lifting in the **Z** direction relative to plate piece **61** in the regions of the sliding joints. The

sliding joints **66** and **67** allow sliding in the **X** direction to enhance the longitudinal flexibility of platform retention assembly **70** when standard fasteners are used to fasten the slots of groups **34** and **35** to the snowboard. In contrast with the embodiment of **FIG. 6** where special fasteners are optionally used to enable sliding in the **X** direction at slots **35**, the embodiment of **FIG. 10** spreads out the points of siding contact laterally (in the **Y** direction). When the points of sliding contact are spread laterally, the clearance that is necessary to permit sliding in the sliding joint will cause less backlash in the torque transfer from rider to snowboard during normal use than it would if the points of sliding contact were closer together. Lateral spreading of the points of sliding contact is therefore desirable because it enhances the snowboarder's ability to control the snowboard by applying torques through the safety device to the snowboard with less backlash.

The embodiment of **FIG. 10** also better facilitates longitudinal bending because ribs **37** and **38** have been replaced by vertical pegs **68** and **69** that have a shorter longitudinal dimension (i.e. shorter dimension along the **X** axis). Like ribs **37** and **38**, vertical pegs **68** and **69** resist pure lateral sliding of the binding support platform, and are positioned in a circular arrangement with ribs **36** and **39** to permit rotation about the **Z** axis. Vertical pegs **68** and **69** are also given some vertical curvature (i.e. their outside surface that is slightly curved in the **Y - Z** plane) so as to permit lifting of one edge of binding support platform **10** in the **Z** direction (as would occur if binding support platform **10** separated from the snowboard as a result of a torque about the **X** axis). Slots **62 - 65** also help facilitate longitudinal bending of plate piece **60** in the embodiment of **FIG. 10**.

Another preferred embodiment that better facilitates longitudinal bending is shown in **FIGS. 11-14**. Longitudinal bending is facilitated in the preferred embodiment of **FIGS. 11-14** because region **13** of binding support platform **71** does not protrude in the **Z** direction relative to the level of regions **11** and **12**. The low vertical profile of binding support platform **71** in the embodiment of **FIGS. 11-14** is achieved because the binding support platform does not cover preloaded plunger assemblies **74** - **77**. Preloaded plunger assemblies **74** - **77** are fastened to underlying plates **72** and **73** in this embodiment. Underlying plates **72** and **73** are fastened to the snowboard by standard fasteners passing through holes and/or slots in groups **34** and **35** and anchoring in shallow threaded holes of groups **6** and **7** in snowboard **1**. Underlying plates **72** and **73** longitudinally extend beyond of the leading and trailing edges of binding support platform **71** in this embodiment, and preloaded plunger assemblies **74** - **77** are fastened to areas of underlying plates **72** and **73** that are not covered by binding support platform **71**. Whereas the preferred embodiments shown in **FIGS. 5 - 8**, and **FIG. 10** included preloaded plunger assemblies that were located within region **13** and that were oriented to have their retention plungers pointed outward, the preloaded plunger assemblies **74** - **77** of the preferred embodiment shown in **FIGS. 11-14** are located outside of region **13** and are oriented to have their retention plungers pointing inward. Because of the location and orientation of preloaded plunger assemblies **74** - **77**, the preferred embodiment shown in **FIGS. 11-14** does not include a single adjustment cam capable of simultaneously adjusting the preload force of each plunger assembly. Instead, the preload force of each plunger assembly **74** - **77** is individually adjusted in the embodiment of **FIGS. 11-14** by turning and locking a threaded adjustment plunger pertaining to each preloaded plunger assembly **74 - 77**.

In the preferred embodiment of **FIGS. 11-14**, the retention plungers of preloaded plunger assemblies **74 - 77** interface with contours **78 - 81** that are part of or fastened to binding

support platform **71**. In the embodiment of **FIGS. 11-14**, contours **78 - 81** include facets (similar to facets **52** and **53** shown in **FIG.** 7) that are oriented so that the interfaces between preloaded plunger assemblies **74 - 77** and contours **78 - 81** can resist limited torques about the **Z** axis and limited separation forces in the **Z** direction. The interfaces between the retention plungers of preloaded plunger assemblies **74 - 77** and contours **78 - 81** of the binding support platform **71** also allow the binding support platform **71** to release from underlying plates **72** and **73** if separation torques or forces encountered while snowboarding exceed a threshold. The threshold is set by the designer's choice of angular orientation for facets in contours **78 - 81** and by the user's adjustment of each retention plunger's preload force. To prevent runaway of the snowboard in the event of release, the preferred embodiment of **FIGS. 11-14** optionally includes leash **19** that is shown in **FIG. 11** having one end attached to underlying plate **73** and the other end attached to the binding support platform.

In the preferred embodiment of **FIGS. 11-14**, binding support platform **71** includes downwardly protruding ribs **84 - 87** that are part of or are fastened to the underside of region **13** of binding support platform **71**. Downwardly protruding ribs **84 - 87** contact the inner edges **82** and **83** of underlying plates **72** and **73**, and thereby prevent binding support platform **71** from translating purely in the **X - Y** plane relative to the snowboard. Inner edges **82** and **83** of underlying plates **72** and **73** are curved and arranged to lie on a single circle so that contact with downwardly protruding ribs **84 - 87** does not, by itself, prevent rotation of binding support platform **71** about the **Z** axis relative to the snowboard.

In an alternative embodiment, the radius of curvature of inner edges **82** and **83** could be reduced such that inner edges **82** and **83** form the common inner edge of a large circular hole in a single underlying plate formed by the joining of underlying plates **72** and **73** along their lateral edges. However, the separation of underlying plates **72** and **73** in the preferred embodiment of **FIGS. 11-14** is desirable because that separation enhances longitudinal flexibility. In another alternative embodiment, downwardly protruding ribs **84 - 87** could be removed from region **13** of binding support platform **71**, being replaced by upwardly protruding ribs or pegs attached to and rising from underlying plates **72** and **73** adjacent to preloaded plunger assemblies **74 - 77** (or as part of the housing of each preloaded plunger assembly). However, the more central location of ribs **84 - 87** in the preferred embodiment of **FIGS. 11-14** is desirable because it allows mating edges **82** and **83** to have more curvature while still being in circular arrangement to permit rotation about the **Z** axis. Sufficient curvature of inner edges **82** and **83** enables ribs **84 - 87** to effectively resist pure lateral translation of binding support platform **71** relative to the snowboard.

In the preferred embodiment of **FIGS. 11-14**, downwardly protruding ribs **84 - 87** also optionally perform a helpful function as a positioning template when underlying plates **72** and **73** are fastened to the snowboard. During one optional procedure for fastening underlying plates **72** and **73** to the snowboard, underlying plate **73** is first firmly fastened to the snowboard using the through holes in group **34**, while underlying plate **72** is temporarily loosely fastened to the snowboard using the through slots in its group **35**. Next, the adjustable preload forces of plunger assemblies **74** - **77** are temporarily reduced as much as possible. Next, binding support platform **71** is positioned over the firmly fastened underlying plate **73** so that downwardly protruding ribs **85** and **87** are in simultaneous contact with inner edge **83**. Next, underlying plate **72** is slid under binding support platform **71** until it is

positioned such that inner edge **82** is in simultaneous contact with downwardly protruding ribs **84** and **86**. Next, underlying plate **72** is held in position while binding support platform **71** is temporarily removed, and the fasteners fastening underlying plate **72** to the snowboard are tightened.

The preferred embodiments shown in **FIGS. 5 - 8**, **FIG. 10,** and **FIGS. 11-14** all include four preloaded plunger assemblies. An alternative embodiment, illustrated in **FIGS. 15** and **16,** includes only three preloaded plunger assemblies positioned with greater average angular separation. The alternative embodiment of **FIGS. 15** and **16** is less costly because it has fewer parts. However, the use of four preloaded plunger assemblies has a performance advantage because it allows a configuration where a retention plunger interface can be located near each interior corner of the binding support platform (in the case of the embodiments of **FIGS. 5-8** and **FIG. 10**) or exterior corner of the binding support platform (in the case of the embodiment of **FIGS. 11-14**). Locating the interfaces near the corners spreads the torque transfer locations, increasing the leverage with which the snowboarder can apply out-of-plane torques through the safety device to the snowboard. Such an increase in leverage gives the snowboarder better control over the snowboard under normal operating conditions.

FIG. 15 illustrates a platform retention assembly in a lower-cost alternative embodiment having three preloaded plunger assemblies, and **FIG. 16** illustrates a binding support platform in that lower-cost alternative embodiment. Referring now to **FIG. 15**, it can be seen that the platform retention assembly of this alternative embodiment includes three retention plungers **88 - 90**. Retention plungers **88**, **89**, and **90** interface with interior contours **96**, **94**, and **95** of the binding support platform, respectively. Interior contour **94** includes facets that form a relative angle less than 180° in the **X - Y** plane in order to enable the interface between interior contour **94** and retention plunger **89** to resist rotation of the binding support platform about the **Z** axis relative to the platform retention assembly. The facets of interior contour **94** are also tilted relative to the **Z** axis in order to enable the interface between interior contour **94** and retention plunger **89** to resist vertical separation of the binding support platform relative to the platform retention assembly. Interior contours **95** and **96** optionally do not include facets that form a relative angle less than 180° in the **X - Y** plane. Therefore, in the embodiment shown, interior contours 95 and 96 can not by themselves resist rotation of the binding support platform about the Z axis relative to the platform retention assembly. Interior contours **95** and **96** include facets tilted relative to the Z axis that enable the interfaces between interior contours **95, 96** and retention plungers **88, 90** to resist vertical separation of the binding support platform relative to the platform retention assembly.

In the alternative embodiment of **FIG. 15**, ribs **36 - 39** have been replaced by three vertical pegs **91 -93** which serve to prevent translation of the binding support platform in the **X - Y** plane, relative to the platform retention assembly. Pegs **91**, **92**, and **93** contact interior surfaces **99**, **98**, and **97** of the binding support platform, respectively. Pegs **91**, **92**, and **93** are in circular arrangement and therefore do not, by themselves, prevent rotation about the Z axis of the binding support platform relative to the platform retention assembly.

The preferred embodiments shown in **FIGS. 5 - 8**, **FIG. 10**, **FIGS. 11-14,** and **FIGS. 15-16** all include retention plunger assemblies that are fastened to a plate that is fastened to the snowboard. However, in another preferred embodiment, the retention plunger assemblies are

fastened to the binding support platform so that the binding support platform and retention plunger assemblies would constitute a single assembly, and that single assembly would interface with contours or facets fastened to the snowboard. **FIG. 17** is an underside view of the binding support platform in a preferred embodiment of the disclosed invention in which the binding support platform and most of the retention mechanism form a single assembly. In the preferred embodiment shown in **FIG. 17**, retention plunger assemblies are fastened to cover surface **31** on the underside of region **13** of the binding support platform.

In the preferred embodiment shown in **FIG. 17**, adjustment cam **100** does not have slots similar to slot **49** shown in **FIG. 7**. Adjustment cam **100** of **FIG. 17** does not require slots because the user is able to rotate and lock adjustment cam **100** by means of a knob and locking mechanism on the other side of cover **31** (i.e. on the top surface rather than underside of region **13** of the binding support platform). The knob controls the angular position of adjustment cam **100** via keyed shaft **101** which passes through cover surface **31**.

FIG. 18 is a top view of platform retention plate **21** in a preferred embodiment of the disclosed invention in which the binding support platform and most of the retention mechanism form a single assembly. Retention contours **102 - 105** rise from the surface of retention plate **21** and interface with retention plungers of the binding support platform assembly. Retention plate **21** optionally includes large hole **106** in the embodiment of **FIG. 18** in order to enhance longitudinal flexibility.

FIG. 19 is a simplified side-view cross-sectional illustration of the interface between the binding support platform assembly and one retention contour on the platform retention plate in a preferred embodiment of the disclosed invention in which the binding support platform and most of the retention mechanism form a single assembly. **FIG. 19** is simplified in the same manner and aspects as previously described with regard to **FIG. 9**. Referring now to **FIG. 19**, retention contour **109** is fastened to, or part of, platform retention plate **21**. The retention plunger assembly that includes retention plunger **46** is fastened to region **13** of the binding support platform. Facet **107** of retention contour **109** is tilted with respect to the vertical (**Z**) axis. The angle of vertical tilt of facet **107** significantly affects the vertical separating force required to separate the binding support platform from platform retention plate **21**. Facet **108** of retention contour **109** is tilted with respect to the **Z** axis so as to enable forcible reattachment of the binding support platform assembly on to the snowboard without requiring the user to first unlock and rotate cam **100**. To accomplish forcible reattachment, the user first positions the binding support platform assembly over the platform retention plate such that retention plunger **46** is resting on top of facet **108**. Next, the user presses the binding support platform down so that retention plunger **46** is momentarily forced to the left (as viewed in **FIG. 19**), and then, as the retention plunger again moves to the right, the point of contact between retention plunger **46** and the retention contour **109** moves from facet **108** to facet **107**.

The foregoing description of embodiments of the invention has been presented to provide illustration and description of practical applications of the principles of the invention sufficient to enable one of ordinary skill in the art to utilize the invention in various embodiments and with various modifications as are suited to the particular use contemplated. The embodiments described are not intended to be exhaustive or to limit the invention to the precise forms disclosed; on the contrary, the scope of the present invention is limited only by the terms of the appended claims.